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# Unmanned Aerial Vehicle: A Tool for the Operational Commander

by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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Abstract of

***Unmanned Aerial Vehicle: A Tool for the Operational Commander***

The United States has become more dependent upon technology to maintain its warfighting edge in an era of reduced manpower and increasing weapon lethality. This paper addresses the employment of the unmanned aerial vehicle (UAV) to achieve a force multiplier effect for the operational commander. The UAV is able to counter the imbalance of the high risk-to-benefit ratio by substituting programmable, non-lethal aerial vehicles for costly-to-replace manned aircrews and aircraft. This paper presents a historical overview of the evolving military application of the UAV, and a summary of the equipment and characteristics resident in current UAV programs. Additionally, the author provides a correlation of the UAV's functions with certain aspects of Operational Art, and an assessment of the employment of the UAV's capabilities to support current military missions. The UAV is a cost-effective technology that can reduce the operational commander's reliance upon strategic information services, and reduce the risk and political sensitivities associated with the loss or capture of service members.

## *INTRODUCTION*

The United States has become more dependent upon technology to maintain its warfighting edge in an era of reduced manpower and increasing weapon lethality. The imbalance of the risk-to-benefit ratio for use of available manpower within a hostile environment requires the operational commander to employ other resources to get "eyes" on the target. Unmanned aerial vehicles (formerly referred to as remotely piloted vehicles) provide the commander with a capability to "see" the battlefield and influence the outcome of events without risking human assets. Differentiated from drone or "dumb" air vehicles, the much more capable unmanned aerial vehicle (UAV) receives active flight profile guidance from a ground station, and may be employed in a lethal or non-lethal mode. This paper addresses the development and application of the non-lethal unmanned aerial vehicle as an asset for the operational commander.

Recognition of the need and subsequent development of the unmanned aerial vehicle by the US armed services began during the early years of the Cold War era. However, the concept ebbed and waned with cycles of political or military urgency. Now, renewed interest due to technological advancements and risk aversion for US combatants enables the *capabilities* of the UAV to more closely fulfill the *requirements* of the military mission.

This paper provides a historical overview of the military UAV application; a summary of the equipment and capabilities resident in the current UAV programs; a correlation of the UAV's functions with certain aspects of Operational Art; and an assessment of UAV capabilities to support the mission requirements of the operational commander. This methodology supports the author's contention that the UAV is a unique and highly effective "tool" for the operational commander.

## *HISTORY*

> One of the surest ways of forming good combinations in war would be to order movements only after obtaining perfect information of the enemy's proceedings. In fact, how can any man say what he should do himself, if he is ignorant of what his adversary is about? [1]
>
> Jomini

In the late 1950s the Eisenhower administration sought to monitor the expansion of the Soviet Union's military arsenal, and proposed an agreement for both nations to allow territorial overflight for aerial surveillance, "Open Skies," to ease international tensions.[2] When the Soviet Union rejected the proposal, President Eisenhower authorized covert flights using manned U-2 aircraft to acquire the desired intelligence. Unfortunately, the covert operation was exposed when the Soviet air defenses detected and shot down the aircraft, and captured the pilot, Major Francis G. Powers. The international uproar and embarrassment that resulted from the incident highlighted the need for the United States to reduce its vulnerability without forfeiting the necessary function of intelligence gathering. That first incident, and two subsequent shootdowns of U-2 aircraft and deaths of the American flight crews stimulated a resolve for the Federal Government to sponsor government-industry programs to produce an unmanned aerial vehicle (UAV) for long-range strategic reconnaissance.[3]

The United States introduced UAVs into a combat environment during the Vietnam War years. The initial entry UAV equipment, which was off-the-shelf technology, successfully validated the proof-of-concept while performing missions of photo reconnaissance, pre-strike electronic countermeasures (ECM), bomb damage assessment (BDA), and psychological operations (leaflet drops).[4] The UAV experience in Vietnam, although effective, did not garner enthusiastic support and funding within the Department of Defense

because the unmanned capability was regarded as a distraction and threat to the growth of the manned air forces. As a result, institutional resistance inhibited development of a battlefield UAV, although the Air Force continued to pursue a high-altitude, long-endurance UAV to complement the manned U-2 aircraft.[5]

Although U.S. military interest in the development of a battlefield UAV declined, the Israeli military's successes in the Israeli-Arab War (1973) and later against Syria (1982) were attributed to effective use of UAVs. In both wars, Israel used its UAVs for reconnaissance, radar jamming, deception, and target acquisition.[6] In recognition of this proven capability of the UAV as a battlefield asset, the U.S. Army incorporated the UAV in the doctrinal revision of its Field Manual 100-5, *Operations*, in 1986.[7]

The next significant use of UAVs by U.S. forces occurred during the Gulf War (1990-1991). The UAV systems that were deployed to the Persian Gulf were the Pointer, a close range (3 nautical mile (nm); 1.2 hour flight endurance) vehicle, and the Pioneer, a short range (100 nm; 5 hour flight endurance) vehicle. The Pointer's design characteristics limited its use to basic observation missions for small units. The Pioneer was assigned more diversified tasks, taking advantage of its ability to perform day/night reconnaissance, surveillance, target acquisition (RSTA), battle damage assessment (BDA), and battlefield management. The acceptance of the UAV as a reliable force multiplier for the field commander was summarized in a statement by MG Paul Menoher, Jr., "DESERT STORM made more friends for UAVs than you can imagine. Now every field commander wants them." [8]

Moving forward in years to the U.S. peace enforcement and peace keeping roles in Bosnia and Kosovo, the UAV was an integral element of US forces deployment, and the US systems were augmented by UAV systems provided by coalition partners—Great Britain,

France, and Germany. As reported in the Defense Airborne Reconnaissance Office *UAV Annual Report (FY 1997)*, the deployment of UAVs to support joint and combined operations in the Balkans was a major "success story."[9]

When the focus of the NATO air strikes in Operation Allied Force (1999) shifted from man-made terrestrial targets (bridges, power facilities, industrial complexes, etc.) to attacks on Serbian troop assembly areas, UAVs became the principle asset to enable target selection. The orbit cycles of reconnaissance satellites could not provide long duration observation and could be defeated by the enemy's operational security measures. Also, weather conditions and the enemy's extensive anti-air defenses limited aerial observation from manned aircraft. To overcome these operational barriers, UAVs were deployed to the Tuzla Air Base, Bosnia, for reconnaissance and surveillance over Kosovo.[10] Operating at altitudes that were difficult to detect visually or aurally, the UAVs provided the needed surveillance of troop movements and assembly areas, airfields, and monitored traffic flow on roads. The recorded images were transmitted to the controlling ground stations for analysis, which prompted air strikes as needed. As stated by Army LTC Bill Wheelan, "The beauty of any UAV is that it lets the battlefield commanders see what's happening 10, 20, 30 miles away, and he doesn't have to fly a helicopter with a four [man] crew on board."[11] The UAV had, once again, demonstrated its credibility as a key asset for the commander.

## *UNMANNED AERIAL VEHICLE CHARACTERISTICS AND CAPABILITIES*

*We received an inkling of what combat will look like in the 21st Century during DESERT STORM, and recently in our support of NATO action in Bosnia. In both cases unmanned aerial vehicles have demonstrated the ability to provide continuous real-time battlefield surveillance.* [12]

*Dr. Paul G. Kaminski*
*Former Undersecretary of Defense (A&T)*

In 1988, Congress directed the Department of Defense to consolidate the management of non-lethal UAV programs. In response to the Congressional mandate, the Services established the DoD Joint UAV Program Office and began to define a joint strategy for UAV development and acquisition.[13] The subsequent *Unmanned Aerial Vehicle Master Plan 1991* defined four categories of UAVs based on range and endurance.

| Category | Radius of Action | Flight Endurance |
|---|---|---|
| Close Range | 50 Km | 8 Hours (min.) |
| Short Range | 150 Km beyond the Fwd Line of Troops | 8 – 12 Hours |
| Medium Range | 650 Km | 2 Hours |
| Endurance | (Classified) | 24 Hours on station |

Source: Department of Defense, *Unmanned Aerial Vehicle Master Plan, 1 March 1991*

In November 1993, the Defense Airborne Reconnaissance Office (DARO) was created to unify the existing reconnaissance architectures, and enhance the management of manned and unmanned airborne assets. The transition of program management to DARO provided an opportunity to re-assess the former classification structure, which tended to pigeonhole the developing aerospace technologies within the artificialities of range and endurance.

Alternatively, DARO redefined the UAV categories with primary consideration of the *functional* requirements for reconnaissance across a range of battle conditions, as well as peacetime. The new strategy, the Objective Architecture, created a new reconnaissance vision with a focus on systems that could provide nearly perfect, real-time information to the

commander in the field.[14] The new categories partition the atmosphere into altitude strata, and assign the UAV to the appropriate vertical segment based on the vehicle's operating ceiling.

| Category | Designation | Altitude (max.) |
|---|---|---|
| Tier I | Joint Tactical | 15,000 ft. |
| Tier II | Medium Altitude Endurance | 25,000 ft. |
| Tier II (+) | Conventional High Altitude Endurance | 65,000 ft |
| Tier III (-) | Low Observable High Altitude Endurance | 45,000 ft |

Source: Defense Technical Information Center, *Annual Report Unmanned Aerial Vehicles August 1995*. Ft. Belvoir, VA, p 27.

Tier I: Joint Tactical UAV (TUAV)

The goal of the TUAV is to provide near real time reconnaissance, surveillance, target acquisition (RSTA), and battle damage assessment (BDA) to support Army echelons below Corps level, Marine brigades, and deployed Navy vessels.[15] To meet joint requirements, the TUAV must deliver timely accurate RSTA information at ranges up to 200 km with an on-station endurance up to four hours. The *Outrider* TUAV is designed for both land-based and shipborne operations, with automatic takeoff and landing for short unimproved ground surfaces or large-deck amphibious ships.[16]

**Figure 1: Outrider TUAV**

OUTRIDER Performance Characteristics

| | |
|---|---|
| Altitude (max.) | 15,000 ft. |
| Range (radius of action) | ≥108 nm. / ≥ 200 km. |
| Endurance | 3.6 hrs @ 100 km. |
| Cruise Speed | 90 kts / 167 km/hr |
| Deployment needs | C-130 (drive on/off)<br>LHA/LHD (RO-RO) |
| Sensors | Electro-Optic (EO)<br>Infrared (IR) |

Source: Defense Airborne Reconnaissance Office *UAV Annual Report FY 1997*, p 22

Tier II: Medium Altitude Endurance (MAE) UAV

The *Predator*, formerly known as the MAE or Tier II UAV, provides long-range, long-dwell, near real-time imagery intelligence to satisfy RSTA mission requirements. It carries both EO/IR and synthetic aperture radar (SAR) that, with Ku-band satellite communication links, enable the system to acquire and pass highly accurate imagery to ground stations for theater-wide use.[17]

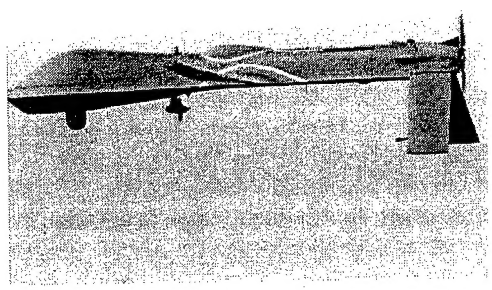

**Figure 2: Predator (MAE UAV)**

Predator Performance Characteristics

| | |
|---|---|
| Altitude (max.) | 25,000 ft. |
| Range (radius of action) | 400 nm. / 740 km. |
| Endurance | 35 hrs |
| Cruise Speed | 65-70 kts / 120 km/hr |
| Deployment needs | Multiple C-130 sorties |
| Sensors | EO, IR and SAR |

Source: Defense Airborne Reconnaissance Office *UAV Annual Report FY 1997*, p 23

TIER II(+): Conventional High Altitude Endurance UAV

The *Global Hawk*, formerly identified as the Tier II+ UAV, is planned as the HAE UAV "work horse" for missions requiring long-range deployment and wide-area surveillance with long sensor dwell over the target. It will operate at ranges up to 3,000 nm. from its launch area, with on-station loiter capability of 20 hours (at that range), at altitudes exceeding 60,000 feet. It will employ both EO/IR and SAR sensors to generate both wide-area and spot imagery while standing off from high-threat areas. It will have both line-of-sight (LOS) and satellite data link communications. The HAE Common Ground Segment provides both launch and recovery, and its mission control elements (LRE and MCE).[18]

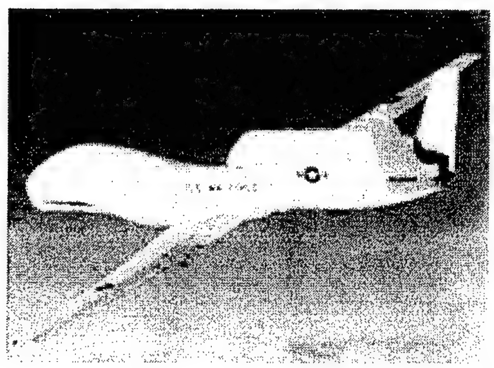

Figure 3: Global Hawk (Conv HAE UAV)

GLOBAL HAWK Performance Characteristics

| | |
|---|---|
| Altitude (max.) | 65,000 ft. |
| Range (radius of action) | 3,000 nm. / 5,556 km. |
| Endurance | 38 hrs / 20 hrs@3,000nm |
| Cruise Speed | 345 kts / 639 km/hr |
| Deployment needs | UAV: self-deployable<br>CGS: Multiple C-141, C-17 or C-5 sorties |
| Sensors | EO and SAR |

Source: Defense Airborne Reconnaissance Office *UAV Annual Report FY 1997*, p 23

Tier III (-): Low Observable High Altitude Endurance UAV

(Program funding has been terminated for development of the *Dark Star*, which was proposed to be the Tier III(-) UAV. The design featured low observable technology to minimize the air vehicle's detectability and provide survivability against air defenses.)[19]

## *UAVs AND OPERATIONAL ART*

Operational Art is defined as "the theory and practice of planning, preparing, conducting and sustaining major operations and campaigns aimed at accomplishing operational or strategic objectives in a given theater."[20] The application of the elements of Operational Art requires military planners to acquire information about the capabilities and intentions of potential or known opponents, as well as comparable information about friendly forces. The UAV is uniquely capable to perform this information gathering function in either benign or hostile environments, while minimizing the hazards or political sensitivities of manned flight. Operational Art comprises multiple component elements. The following paragraphs of this section correlate the UAV's functions to applicable elements of Operational Art.

### *Principles of War*

SECURITY *Never permit the enemy to acquire unexpected advantage.*[21]

The key aspects of security are to reduce the friendly force's vulnerability, which, if successfully attacked by hostile acts, influence, or surprise, may endanger the outcome of an operation. To minimize the vulnerability of his force, a commander can employ the UAV to conduct reconnaissance (searching) or surveillance (monitoring) of an opponent's activities from which decisions can be made to protect against surprise. Additionally, when equipped with the appropriate sensor payload, the UAV could actively monitor the battle space for the presence of life-threatening chemical agents, and transmit an alert to forces maneuvering into or near the danger zone. The safety-of-life information, which would be immediately useful to a tactical commander, would also enable the operational commander to assess the impact of the chemical warfare event on the broader scope of operations.

ECONOMY OF FORCE *Employ all combat power available in the most effective way possible; allocate minimum essential combat power to secondary efforts.*[22]

One's forces should be employed in a manner that will enable accomplishment of an objective with the least amount of force in the shortest possible time.[23] The operational commander endeavors to align a mission's objectives with the organizational assets best suited for the mission. The essential tasks of reconnaissance, surveillance, target acquisition, and battle damage assessment exert exacting demands on manned collection assets; whereas, UAVs are "designed and built for jobs too boring, hazardous, or expensive for aircrews to fly."[24] Manned aircraft have on-station time limitations dictated by fuel consumption and the presence of an opposition threat. Access to in-flight refueling, which can extend the flight period of the aircraft, does not alleviate the aircrew fatigue that can be a dangerous liability. The UAV overcomes those limitations and allows manned aircrews to be kept ready for missions more appropriate and necessary for the aircrews' skills.

MANEUVER *Place the enemy in a position of disadvantage through flexible combat power.*[25]

The ability of the UAV to have extended on-station time ('loitering') is a form of offensive maneuver because it forces an opponent to react with a disadvantageous changes to his actions or plans. Upon awareness of the presence of the UAV, the opponent must decide whether to elude observation by stopping activity and seeking concealment, or to attack the UAV and consequently reveal the location of his air defense systems. In either situation, the unexpected presence of the UAV will force the enemy to commit an action that will provide an advantage to the 'blue' forces. Unlike the predictable 'windows of exposure' associated with a geo-spatial satellite orbit, the unpredictability of a UAV can

force an opponent to execute unplanned alterations, creating confusion and disrupting the momentum of his battle plan.

### *Operational Functions*

OPERATIONAL COMMAND and CONTROL ($C^2$) *The means by which the commander synchronizes joint force activities in time, space and purpose in order to achieve service and functional unity of effort.*[26]

The 21st Century battlefield will be characterized by centralized planning with de-centralized control of execution to accommodate fluid, high tempo operations. The command and control network in this operational environment must be supported with information updates that illuminate dynamic changes as they occur. The UAV demonstrated this unique versatility during its deployment to support multinational military operations in Bosnia. In addition to performing the pre-scheduled flight missions, the system's ability to respond to 'in-flight re-tasking' allowed the senior headquarters to interject flight path changes to areas of command interest. The UAVs returned imagery and sensory data that was disseminated from the controlling ground station, a Trojan Spirit II terminal, through the Joint Broadcast System to theater and international command and control facilities.[27] The near real-time responsiveness of the UAV affirmed the system's ability to respond to multiple levels of command interest.

In addition to 'sending back' information to the $C^2$ infrastructure, the UAV can be adapted to 'carry forward' information from the rear headquarters to far-reaching subordinate commands. An unmanned vehicle launched with a radio relay/retransmission payload provides the commander with communications assets to direct and coordinate operations across the expanse of the battle space. In contrast to the $C^2$ complexities associated with

obtaining support from national assets, such as satellite sensors and communications systems, the operational commander has operational control (OPCON) of the UAV, and thus reduced dependence on national assets.

$C^2$ WARFARE *Deny the opponent the effective use of his operational $C^2$ capabilities, while at the same time protecting friendly $C^2$ functions.*[28]

In contrast to manned aircraft electronic warfare (EW) systems, such as the EA-6B, a UAV equipped with a radio frequency (RF) jammer payload can provide capabilities that are not feasible for the manned aircraft systems. The Joint Command and Control Warfare Center ($JC^2WC$) has demonstrated the utility of deploying the UAV with a low-power jammer against area EW targets. The small cross-sectional profile of the UAV enables a closer, undetected approach to the target. The close proximity of the UAV allows the jammer's lower output power to effectively jam the opponent's transmitter or receiver while avoiding the RF fratricide that the more powerful airborne stand-off systems cause when broadcasting jamming signals across intervening friendly territory toward the enemy.[29]

## *SUPPORT FOR THE OPERATIONAL COMMANDER*

Development of the unmanned aerial vehicle arose from the political necessity to conduct long range reconnaissance of high risk territories. Although initially envisioned as a strategic asset to support national objectives, improvements in the miniaturization of sensors and optics enabled expansion of the UAV role to perform the following tasks for the operational commander and subordinate commands.

- RSTA
- Deception
- Nuclear, Biological and Chemical detection
- Meteorological missions
- Adjustment of indirect fire
- Radio and data relay
- Search and Rescue (peacetime and combat)
- Electronic Warfare
- Special warfare / Psychological operations
- Route and landing zone reconnaissance
- Battle damage assessment
- Maritime defensive operations [30]

Assigning a machine to perform a task in a high risk or hazardous environment gives the commander more flexibility to prevent unnecessary endangerment of his troops and loss of capital equipment. As more UAVs move into the equipment inventory, the impact of a downed or damaged UAV will be substantially less than the loss of an aircrew and its multi-million dollar aircraft.

The "endurance" category UAV is able to penetrate into the enemy's operational depth with a minimally detectable, all-weather flight profile. Its long dwell time, while broadcasting near-real time imagery or data to collection points, meets the commander's need for updated information to plan and make decisions. UAV utility will be greatly enhanced when the received intelligence products are accessible to multiple user levels. Traditional stovepipe collection and dissemination processes matched a requestor to a single-purpose flight mission and its output products. Future improvements in integrated

communications networks will enable the operational commander to approve a requested mission and ensure that the output product is accessible to all who have a 'need-to-know.'

Skeptics previously regarded the development of the UAV as a challenge to the importance of manned aircraft. However, the current conventional wisdom regards the UAV as a complement to the 'heavyweight' attack aircraft. Experimentation and combat experience has demonstrated the force multiplier effects gained by using the UAV in a hunter-killer team with fighter/bomber aircraft. The UAVs can be deployed as the advance guard into enemy territory either to find surreptitiously the anti-air defense locations or to provoke the air defense sites to activate their search radars in an attempt to target the UAV. With either tactic, the friendly forces will be able to identify the danger points for elimination by a suppression of enemy air defenses (SEAD) attack.

The UAV offers a limited capacity for 'forward engagement.' Although the UAV does not convey the sense of presence comparable to a salute and handshake on an airfield tarmac or a meeting with a country's political leadership, a long-endurance UAV can provide a regional CINC with a view of developing events that typically precede a conflict. By receiving the early indicators of a potential troublespot – supported with confirming visual or sensory data, the commander may develop a Commander's Estimate of the Situation before confronting the appropriate political and military representatives. In the past, the controllers of strategic imagery assets have directed this type of reconnaissance. The regional CINC was a recipient of the intelligence products, but could not control the timeliness or quality of the information received. The OPCON relationship between the regional CINC and the UAV component command ensures a more timely response to operational requirements.

## *CONCLUSIONS*

The National Military Strategy charges the operational commander to use the resources of his command to *shape* the political and military environment, and be prepared to *respond* to crises across the full spectrum of conflict. The modern unmanned aerial vehicle is a multi-purpose platform that can perform tasks across the spectrum of conflict: from humanitarian aid to civil disturbance to low intensity conflict to conditions of war. Improvements in optical and sensory technologies, and opportunities to demonstrate solutions to real-world problems have enabled the UAV to gain a broader acceptance by the military and political communities.

The UAV is uniquely able to provide near real-time reconnaissance and surveillance of areas of interest to the operational commander. Capable of operating in either benign or hostile airspace, the UAV assists the commander to complete the planning process and develop an operational assessment by providing updates of the operational situation.

The UAV is an asset that is within the commander's operational control, thereby reducing dependence upon strategic reconnaissance services, which may not be available due to competing priorities. UAVs are cost effective, and diminish the risk and political sensitivities caused by loss or capture of service members. The aircraft payloads are adaptable to a variety of missions, and the ground control terminals are being developed for integrated control of multiple 'birds' on varying missions. The products of the UAV missions will be accessible to multiple users, eliminating the inefficiencies of the "one requestor-one mission" tasking.

In summary, the UAV can be a highly effective "tool" in the commander's kit bag of resources.

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